CLAIMS

1. A hybrid battery arrangement for an electrically powered system in which battery loading is subject to intermittent high power loading, the system including a hybrid battery coupled to supply electric power via a DC link to a load and a control system for controlling application of power to the load, the hybrid battery arrangement comprising:

a high energy density (HED) battery coupled to the DC link;

a high power density (HPD) battery coupled to the DC link; and

a boost converter, including a unidirectional conductor, coupled in circuit between the HED battery and the HPD battery for selectively boosting the voltage from the HED battery to a level sufficient to force current through the unidirectional coupler to the HPD battery.

2. The hybrid battery arrangement of claim 1 wherein the HED battery includes an assembly of HED batteries and the boost converter includes a plurality of boost converters, each of the boost converters being coupled between a respective one of the HED batteries and the HPD battery.

3. The hybrid battery arrangement of claim 1 further including a dynamic retarder coupled in circuit between the HPD battery and the HED battery for controlling voltage of the DC link to within selected levels of the nominal operating voltage of the HPD battery.

4. The hybrid battery arrangement of claim 3 wherein the HED battery comprises at least one mechanically rechargeable battery, and wherein the unidirectional coupler prevents current from flowing from the HPD battery to the HED battery.

5. The hybrid battery arrangement of claim 3 wherein the boost circuit comprises:

an inductor coupled between the HED battery and the unidirectional conductor;

a first switch coupled at a junction of the inductor and the unidirectional conductor; and

a control system for selectively gating the first switch into conduction for establishing a current through the inductor and for gating the first switch out of conduction whereby the inductor current is forced through the unidirectional conductor.

6. The hybrid battery arrangement of claim 3 wherein the dynamic retarder comprises the serial combination of a power dissipating resistance and a second switch with the control system operable to selectively gate the second switch into and out of conduction in a manner to control the voltage across the HPD battery.

7. The hybrid battery arrangement of claim 1 wherein the HED battery comprises an electrically rechargeable battery.

8. The hybrid battery arrangement of claim 7 wherein the HED battery comprises a sodium-nickel-chloride battery, a lithium-ion battery, or a nickel-metal-hydride battery.

9. The hybrid battery of claim 7 further including a switch connected in parallel with the unidirectional conductor for selectively permitting current transfer to the HED battery.

10. The hybrid battery of claim 1 further including a diode serially connected between the HED battery and the boost converter, the diode being poled to block current from the boost converter to the HED battery.

11. The hybrid battery arrangement of claim 10 wherein the HED battery comprises an assembly of mechanically rechargeable batteries,

the diode includes a plurality of diodes,

and the boost converter includes a plurality of boost converters,

each of the mechanically rechargeable batteries being isolated from others of the mechanically rechargeable batteries by a corresponding one of the diodes, each of the diodes connecting an associated one of the mechanically rechargeable batteries to a respective one of the boost converters, and each one of the boost converters being coupled to the HPD battery.

12. The hybrid battery of claim 10 further including a switchconnected in parallel with the unidirectional conductor for selectively permitting current in a reverse direction through the boost converter, the system including auxiliary loading devices connected in circuit between the diode and the boost converter for utilizing the reverse current.

13. A hybrid battery power system for an AC electric motor, the system comprising:

a direct current (DC) link;

an inverter coupled between the DC link and the at least one ac motor; and

a high energy density (HED) battery and a high power density (HPD) battery, each battery being coupled in circuit with the DC link such that power is suppliable to the inverter conjointly from the batteries, the DC link being arranged such that regenerative energy from the motor is supplied to the HPD battery and isolated from the HED battery.

14. The hybrid battery power system of claim 13 further including a diode connected in the DC link between the HED battery and the HPD battery, the diode being poled to prevent current flow from the HPD battery to the HED battery.

15. The hybrid battery power system of claim 14 further including a voltage boost circuitconnected in circuit with the HED battery for selectively enabling transfer of power from the HED battery to the HPD battery.

16. The hybrid battery power system of claim 15 wherein the voltage boost circuit comprises the series combination of an inductor and a controllable electronic switch, the inductor being serially connected between the HED battery and the diode, the switch being connected to a junction mediate the inductor and the diode and arranged to place the inductor in a short-circuit position across the HED battery for establishing a current therethrough when the switch is conducting, and a control system coupled to the switch

for selectively gating the switch into and out of conduction for boosting current through the diode to the HPD battery.

17. The hybrid battery power system of claim 16 and including a dynamic retarder coupled to the DC link at the HPD battery for controlling the voltage on the DC link.

18. The hybrid battery power system of claim 17 wherein the dynamic retarder comprises the series combination of a power resistor and a second electronically controllable switch, the second switch being selectively gated into and out of conduction so as to vary the effective resistance appearing on the DC link for limiting the magnitude of voltage on the link.

19. The hybrid battery power system of claim 17 further including at least one electrically powered accessory device coupled to the DC link for capturing regenerative power.

20. An traction drive system comprising:

an electric traction motor;

a traction drive converter coupled to supply power to the motor;

a mechanically rechargeable battery;

a DC link for coupling DC power from the battery to the traction drive converter;

a diode connected in the DC link for blocking power transfer from the traction drive converter to the battery; and

a dynamic retarder connected to the DC link for utilizing power at least when the motor is operating in a regenerative mode.

21. The traction drive system of claim 20 further including a voltage boost converter connected in the DC link for increasing an effective voltage magnitude of the battery.

22. The traction drive system of claim 21 wherein the motor is a three-phase machine and the traction drive converter includes three phase-legs for supplying three-phase, controlled frequency electric power to the motor.

23. The traction drive system of claim 22 wherein the traction drive converter includes a plurality of controllable electric switching devices and the system includes a control system for supplying gating signals to each of the switching devices for selectively operating the traction drive converter for transferring power to the motor in a motoring mode and for controlling transfer of electric power from the motor for operating the motor in an electric retarding mode.

24. The traction drive system of claim 22 wherein the dynamic retarder is operable to regulate voltage on the DC link.

25. The traction drive system of claim 22
further including a plurality of diodes, wherein
the battery comprises an assembly of mechanically rechargeable batteries,
the boost converter includes a plurality of boost converters, and
each of the batteries is isolated from others of the batteries by a corresponding one of plurality of diodes, each of the diodes connects an associated one of the batteries to a respective one of a

plurality of boost converters, and each of the boost converters is coupled to the DC link.

26. An alternating current (AC) electric traction motor system comprising:

an AC electric traction motor;

a mechanically rechargeable battery;

a direct current (DC) link coupled to the battery;

a bi-directional DC to AC and AC to DC inverter connected between the DC link and the AC motor;

a voltage boost converter connected in the DC link and adapted for selectively boosting voltage from the battery to a level sufficient to transfer current to the DC link, the boost converter including a diode for blocking current from the link to the battery, and further including a controllable switching device connected in anti-parallel with the diode for selectively passing current in a reverse direction through the boost converter;

a second diode connected in the DC link between the battery and the boost converter for blocking current from the boost converter to the battery; and

auxiliary load devices coupled to the DC link between the second diode and the boost converter for utilizing reverse current from the boost converter.

27. The traction motor system of claim 26 further including a dynamic retarder coupled to the DC link between the inverter and the boost converter, the retard circuit being selectively operable to regulate voltage on the DC link at the inverter.

28. The traction motor system of claim 27 wherein the dynamic retarder comprises a power resistorcoupled to a controllable electronic switch for modulating the effective resistance of the resistor.

29. The traction motor system of claim 26 wherein

the battery comprises an assembly of batteries,

the diode includes a plurality of diodes,

and the boost converter includes a plurality of boost converters,

each of the batteries being isolated from others of the batteries by a corresponding one of the diodes, each of the diodes connecting an associated one of the batteries to a respective one the boost converters, and each of the boost converters being coupled to the DC link.